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(57) Mechanical counter for a metering apparatus

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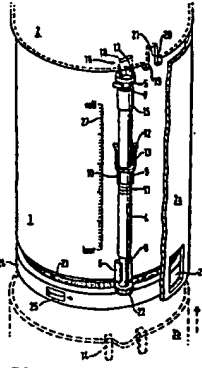


FIG. 1

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Description

[0001] The invention concerns a mechanical counter for a metering apparatus for metering powder, liquid or gaseous substances, and metering apparatus comprising such a counter. The apparatus comprises linear scale means coaxially arranged housing portions, which are rotated relative to each other upon actuation of the apparatus. The number of metering portions of the substance is counted and displayed by the counter.
[0002] An aim of the invention is to provide optimum adaptation of a counter of that kind to handling of the metering apparatus in an operationally reliable manner, and to simplify manufacture of the counter.
[0003] The invention has been particularly thought out exclusively, developed for application to metered dose inhalers (MDI's) such as are disclosed in US Patent 5,672,946 (derived from WO89/11466A), the entire contents of both of which are incorporated herein by reference. Pressure (generally at least 50 bar) is generated in a metered amount of fluid which is discharged through a nozzle assembly having one or more very small openings e.g. in the range 25 to 500 square micrometres. Presently, metered dose inhalers are disclosed in US Patent 5,478,143 (and parallel WO84/07667), the entire contents of both of which are incorporated herein by reference. A locking mechanism is generally provided to hold the spring in the loaded position and is manually releasable to pressurize the metered amount of fluid e.g. using a piston and cylinder arrangement. A reservoir assembly and a metering apparatus are disclosed in US Patent 5,221,153, the entire contents of both of which are incorporated herein by reference. Further details are described in PCT/EP96/0451 and parallel USSR 08/726219, the entire contents of both of which are incorporated herein by reference.
[0004] Metering apparatuses are used for example in medical aerosol therapy for controlled administration of respiratory tracts. In that situation a liquid or powder medicament is aspirated to form an aerosol by means of an airstream or entered into a stream of gas. The medicament is contained in a supply container which is inserted into the metering apparatus. The supply container may be sufficient for several days up to some months. It is therefore necessary to display the consumed amount of medicament or the amount of medication which is still present in the container.
[0005] PCT Patent Application WO-92/01157 provides a display device for a medical metering apparatus. That display device comprises a ring which is rotatable in coaxial relationship with respect to the apparatus and which, for each dose of a medicament under pressure which is taken from the metering apparatus, is automatically incrementally rotated by a certain angle. A display device, a small portion of the ring being visible.

play device is pneumatically actuated when the medicament is inhaled.
[0006] US Patent No. 4 817 622 discloses a display device for a metering apparatus, the display device comprising a linear or a rotatable disk-like scale which is disposed inside the metering device and which is moved by means of a ratchet wheel and a locking pawl. Only a small portion of the scale is visible through a window.
[0007] PCT Patent Publication WO-94/03391 describes a display device for a metering apparatus, which device comprises a disk-like scale with teeth on the periphery of the disk, which is rotated by means of a ratchet member. Only a small portion of the scale is visible through a window.
[0008] PCT Patent Publication WO-95/00324 discloses a display device for a metering apparatus in which the axial movement of the supply container within the housing is transmitted by means of a locking pawl and a worm gear to a rotatable scale of which a small portion is visible through a window.
[0009] In accordance with PCT Patent Publication WO-96/02276 a display device for a medical spray apparatus comprises a digital mechanical counter which is advanced by the movement of the supply container within the housing as soon as a dose of the substance is taken from the supply container. That apparatus comprises a large number of individual parts.
[0010] A display device which is actuated pneumatically or mechanically upon displacement of the supply container, which is under pressure, in the housing of the metering apparatus, is unsuitable for a metering apparatus having two housing portions which are rotatable relative to each other and a supply container which is axially displaced in the metering apparatus.
[0011] Ways were therefore sought of providing a suitable mechanical counter for a metering apparatus having two housing portions which are rotatable relative to each other.
[0012] The invention provides according to one aspect, a mechanical counter for a metering apparatus having two coaxially arranged housing portions which are rotatable relative to each other, which includes at least one spindle, whose axis extends substantially parallel to the axis of the metering apparatus, and which is disposed in the region of the peripheral surface of the metering apparatus and which is mounted to the first housing portion in the vicinity of each of the spindle ends by means of a respective rotary mounting. The spindle has a tooth arrangement at the end which is closest to the second housing portion. Provided at the other end of the spindle is a second tooth arrangement. The second housing portion may be provided with a projection which engages into the tooth arrangement at the other end of the spindle and which is rotatable upon rotation of the two housing portions relative to each other. In order to provide good running properties the transmission assembly, the tooth arrangement at the spindle and the projection are preferably in the form of an involute tooth configuration. Provided on the

spindle is a cursor with rotary securing (prevention of rotation), a scale being disposed opposite same.
[0013] According to another aspect, the invention provides a metering apparatus having two coaxially arranged housing portions which are rotated relative to each other when the metering apparatus is operated, the metering apparatus having a mechanical counter comprising a screwthreaded spindle mounted in bearing means on one of the housing portions in a peripheral region thereof so that it is rotated by movement of the other housing portion, and a cursor mounted, relative to metering means, the arrangement being such that movement of the cursor with respect to the marker means provides a measure of the number of operations of the apparatus.
[0014] Preferred features of the counter and the metering apparatus will now be described.
[0015] The two housing portions are rotated relative to each other to actuate the metering apparatus. The angle of rotary movement may be a preferably integral fraction of 360 degrees, it is preferably 90 to 300 degrees. The relative movement of the two housing portions relative to each other is taken off and converted into a rotary movement of the spindle and a sliding movement of the cursor by means of the transmission assembly which comprises the tooth arrangement at the one end of the spindle and the at least one projection at the edge of the second housing portion. The rotary couplings for the spindle are preferably in the form of imp-action mountings. The transmission ratio of the projection-type transmission assembly is fixed by the number of projections and the number of teeth on the pinion; that also fixes the number of revolutions of the spindle, which corresponds to an actuation of the metering apparatus. For each actuation of the metering apparatus the number of revolutions of the spindle can be less than 1/200 (one-tenth) to 10. The pitch of the screwthread on the spindle is adapted to the number of metering portions which can be taken from the supply container in the metering apparatus, and to the travel of the cursor on the spindle. When the spindle is rotated the cursor on the spindle is displaced relative to the scale which is disposed for example on the first housing portion. The scale is preferably linearly divided. The position of the cursor indicates what proportion of the substance to be metered has already been taken from the supply container and what proportion is still present. The direction of rotation of the counter as the spindle is rotated is the same direction or is the opposite direction to the direction of rotation of the housing portions relative to each other.
[0016] The cursor substantially comprises a display ring at least one line having a rectangular portion and at least one further line with a rectangular projection. There are preferably a plurality of lines and the lines are preferably of a rectangular shape. The screwthread portion is preferably helically engages into the screwthread on the spindle. The cursor can be displaced on the spindle

for metering thereof, by means of the metering projection. That transmission assembly preferably has a transmission ratio of half a spindle revolution to two actuations of the metering apparatus, for example half a revolution to a rotary movement of 360 degrees of the two housing portions relative to each other. A rotational movement of for example 120 degrees of the two housing portions relative to each other is required for actuation of the metering apparatus three times.
[0017] A recess can be provided at the other end of the spindle which is in opposite relationship to the drive portion of the spindle. As soon as the screwthreaded portion on the spindle has reached that recess the cursor ceases to be displaced. The recess serves as a free-motion device for the cursor so that damage to the cursor is avoided if the adjustable travel distance of the cursor on the spindle is exceeded upon further actuation of the metering apparatus.
[0018] Preferably a cover is fixed over the first housing portion to protect the metering apparatus and the counter. The cover is connected to the first housing portion resiliently in an axial direction in a pre-adjusted position. The cover when in the condition of being closed in position cannot rotate relative to the first housing portion. Accordingly the first housing portion can still be rotated with respect to the second housing portion although the first housing portion is covered by the cover.
[0019] The scale which is disposed opposite the cursor is provided either on the first housing portion or on the inside or the outside of the cover. The cover is transparent in a region-view manner or it comprises transparent material.
[0020] At least one rigid restraint means may be provided on the inside of the cover, which restraint means pushes the cursor back into the starting position thereof at the one end of the spindle by means of the metering projections when the cover is closed into place.
[0021] Elastic restraint means may be provided in place of the rigid restraint means. In this case the metering projections of the cursor can be provided with rigid ribs.
[0022] When the cursor is near the cursor stops against a stop at the one end of the spindle before the cover reaches its end position. The cover is further moved to its end position, in which case the elastic portions, that is to say the resilient ribs of the elastic restraint means, springs back and the cursor and the restraint means are unseparated. Accordingly the cursor is in its starting position from which it is displaced when the spindle is rotated.
[0023] In a specific configuration of the counter the pinion at the one end of the spindle has four teeth of which two oppositely disposed teeth are wider than the other two teeth. Provided on the edge of the second housing portion are two projections, between which

there is a recess in which the wider teeth of the pinion can roll. That transmission assembly preferably has a transmission ratio of half a spindle revolution to two actuations of the metering apparatus, for example half a revolution to a rotary movement of 360 degrees of the two housing portions relative to each other. A rotational movement of for example 120 degrees of the two housing portions relative to each other is required for actuation of the metering apparatus three times.
[0024] It is possible to provide the second housing portion with two projections on the second housing portion, which engage into the recesses of the first housing portion relative to each other. Furthermore in this case the projections on the second housing portion may be present only singly. Then the spindle is further rotated only by each third actuation of the metering apparatus.
[0025] The flanks of the wider teeth lie on the inner or outer peripheral surface of the second housing portion. The spindle is therefore rotatable only when the wider teeth can engage into the opening between the projections. That rotary locking arrangement always holds the spindle in the starting position which is provided at the beginning of the rotary movement.
[0026] A plurality of supply containers containing the substance to be metered can possibly be successively fitted into the metering apparatus and used, if the substance to be metered is for example a medicament it may be necessary for reasons of hygiene to limit the permitted number of metering portions with the re-usable metering apparatus. Then it is additionally necessary to count and display the total number of metering portions which have already been discharged with the metering apparatus or the total number of metering portions which are still available. The above-described mechanical counter can be developed in various ways to cover the situation.
[0027] In a first embodiment of such a development a gear is provided on the outer end of the spindle, which is opposite to the drive side. Provided at the corresponding end of the first housing portion is a coaxial ring gear, preferably with a flange, which is mounted rotatably with respect to the first housing portion and after connection of a supply container is displaced axially through a given angle for each revolution of the spindle.
[0028] Provided on the flange is at least one first mark which, after less than a 360 degree rotation of the ring gear relative to the first housing portion and after connection of a supply container is displaced axially through a second mark which is in a fixed position relative to the first housing portion. The number of marks on the flange is equal to the number of supply containers which are permitted to be metered for the metering apparatus (or for the substance to be metered). The second mark can be displaced on the first housing portion or it can be a window in the cover which is fixed onto the first housing portion.
[0029] The flange can be provided, instead of the marks, with a scale which quasi-continuously displays

the total number of metering portions discharged with the metering apparatus or the total number of metering portions still available, for example in a window. The ring gear is rotated through at most 360 degrees to display the maximum permissible metering portions. For this purpose, a high stop-up stop is possibly provided between the rotation of the spindle and the rotation of the ring gear, that stop being structurally fixed by means of a suitable ratio of the number of teeth involved.
[0030] In a second embodiment of the development the cover has a counter indicator in the form of a scale which carries a cursor which is possibly not rotatable. Provided at one of the two ends of the first spindle is a gear which engages into a gear at the corresponding end of the second spindle. Disposed opposite the gear on the spindle is a scale in a fixed position with respect to the first housing portion, which scale can be displaced either on the first housing portion or on the cover (fixed thereon). In the case of this counter the total number of metering portions which have already been discharged or the total number of metering portions which are still available is represented on the displacement travel of the cursor on the second spindle.
[0031] In place of the second spindle with cursor, the arrangement may have a rotatably mounted roller, on the periphery of which a helical line is drawn with an entire revolution over the entire length of the roller. The surface on the two sides of the helical line are marked in different ways, preferably in two colours, for example red and white or red and green. In this construction the cover has a narrow window which is as long as the roller and through which a narrow strip of the peripheral surface of the roller is visible. A scale can be disposed behind the window and extends over the entire length of the roller. The scale can be divided in accordance with the maximum permitted number of metering portions or it can be divided into numbered sections according to the maximum permitted number of supply containers.
[0032] A third embodiment of the development of the counter has a second spindle which is of a similar design configuration to the first spindle but which is displaced at another location in the region of the peripheral surface of the metering apparatus. It is provided with a transmission assembly, similarly to the first spindle, but the transmission ratio is matched to the total number of permissible metering portions. This spindle is driven by projections at the angle of the second housing portion, preferably by the projections which are already used for driving the first gear.
[0033] In order to provide the high stop-up ratio which is possibly required between the first and second spindles or between the first spindle and the ring gear, the arrangement may have, instead of the gear on the first spindle, a single-tooth transmission arrangement with which the gear on the second spindle or the ring gear is further rotated by two teeth for each revolution of the first spindle. The stop-up ratio can be from 2 to 1 to 10

to 1.

[0034] The rotary locking means for the splines or the ring gear (6), the means for holding unassisted movement may be a locking pin or the rotary locking means may be the friction between the splines and the mounting of the ring gear and the mounting or in a specific configuration of the parts, for example a positively locking tooth configuration. The cover is stationary secured on the splines by virtue of the positively locking center of the cursor.

[0035] The components of the counter may consist of virtually any material. They are preferably made from plastic materials, for example by an injection moulding process. For medical purposes, physiologically compatible materials are used such as for example polyethylene-terephthalate (PET) or a compound of PET and Teflon (polytetrafluoroethylene). The materials are preferably so selected that different materials are against each other, for example PET with Teflon against PET or PET against polytetrafluoroethylene.

[0036] The counter according to the invention can be used for example in a metering apparatus which serves as a high-pressure actuator for a liquid medicament. The liquid to be administered is disposed in a pressure-less supply container which communicates with a high-pressure vessel high-pressure generating means with which an excess is generated; for details in this respect see German laid-open application (DE-OS) No. 195 38 922.5 (the contents of which are incorporated herein by reference). The device for producing the high pressure is operated by means of a spring-actuated locking, opening mechanism, the spring being stressed by rotation of two housing portions relative to each other, for details attention is directed to German laid-open application (DE-OS) No. 195 43 236.7 (the contents of which are incorporated herein by reference). The counter according to the invention is substantially indicated when the housing portions are rotated relative to each other.

[0037] A preferred embodiment of the invention will now be described in greater detail with reference to the drawing (Figure 1) which shows part of a metering apparatus having a counter in the embodiment. The first housing portion is rotated through 180 degrees relative to the second housing portion for actuation of the metering apparatus.

[0038] The first housing portion 1 is mounted coaxially rotatably relative to the second housing portion 2. The cover 3 which is mounted thereon covers the first housing portion 1 and the counter. The cover is additionally shown in broken lines in the withdrawn position 3b. The number of metering portions taken from the supply container which is in use at the time is counted with the splines (rotary shaft) 4. The splines 4 is rotatably mounted on the first housing portion by the two opposite mountings 5 and 6 which act as bearings. The groove 7 which accommodates mounting 5 serves for safely fixing the splines. The cover with display ring 8 is provided with two recess lines 10 each having a re-

spective screw-threaded engagement portion 11 and two recessing projections 12 on two limbs 13. The recess 9 is the D-recess means for the portions 11 at the end of their travel. Provided on the inside of the cover are two screw-threaded means 14 which, when the cover is fixed in position, push the cursor 8 back into the starting position at the end of the splines by means of the recessing projections 12. When this happens the cursor ring 8 bears against the abutment 15 and the cover is released as described above.

[0039] Disposed at the one end of the splines is a four-tooth pinion 16 having two (radially) narrow teeth 17 and two (radially) wide teeth 18. The edge of the second housing portion carries the two projections 19 and 20 between which there is the opening 21. As described above, the teeth and projections are preferably of involute shape. Disposed at the other end of the splines is the gear 22 which engages into the ring gear 23. Provided on the flange 24 of the ring gear are a plurality of notched marks 25, of which a respective mark appears in the window 26 in the cover 3e after a given rotary movement of the ring gear.

[0040] The position of the cursor 9 against marker means in the form of the labelled scale 27 shows the number of metering portions taken from the supply container or the number of metering portions which can still be taken therefrom. When the supply container is empty a respective one of the marked marks 25 appears in the window 28.

[0041] The illustrated counter incorporates the preferred features of the invention discussed above (but not the second and third "development" discussed above) and the description just given should be read in conjunction with earlier discussion of these preferred features.

[0042] The preferred counter according to the invention has the following advantages:

- it is automatically actuated when the metering apparatus is actuated;
- it is non-critical in terms of tolerance and is therefore reliable and easy to assemble;
- the transmission can be designed to cover a wide range;
- it displays the number of discharged metering portions and/or the number of metering portions still available, quasi-continuously and with an adequate degree of accuracy;
- it is incompressible and cannot be displaced by cable when using the metering apparatus;
- it can be used for a plurality of supply containers in succession;
- it can be produced for a different number of metering portions from each supply container and for a different maximum number of supply containers which may be used with a metering apparatus;
- it is integrated into the metering apparatus and does not require any additional modification thereof;
- it can be produced in unidirectional form and there-

fore takes up only a small amount of space;

- the individual parts of the counter are preferably made from plastic material which operates without lubricant at a low level of friction;
- no substances can get into the substance to be metered, from the counter;
- it comprises a small number of individual parts which can be inexpensively produced by injection moulding;
- it is easy to assemble;
- the counter can be reset each time a supply container is emptied, as a result the starting position of the cursor on the splines is clearly established whenever a fresh supply container is introduced;
- the combination of a splines which counts the operations of the metering apparatus during use of a supply container with a second splines or with a ring gear means that the metering apparatus can be reliably used for a predetermined total number of metering portions or for a predetermined total number of supply containers in succession. The period of use of the metering apparatus can be reliably reviewed.

Claims

1. A mechanical counter for a metering apparatus having two coaxially arranged housing portions which are rotated relative to each other when the metering apparatus is operated, the counter comprising
 - at least one splines with a screw thread thereon,
 - whose axis extends substantially parallel to the axis of the metering apparatus and
 - which is disposed in the region of the peripheral surface of the metering apparatus and
 - which is mounted in the vicinity of the splines ends with respective rotary mountings on the first housing portion,
 - a tooth arrangement at the splines end which is closest to the second housing portion,
 - at least one projection at the edge of the second housing portion, for engaging the tooth arrangement and rotating the splines,
 - a cursor movable along the splines by the screw thread and
 - a scale which is disposed adjacent the cursor.
2. A mechanical counter according to claim 1 having
 - two rotary mountings, preferably in the form of snap-action mountings.
3. A mechanical counter according to claim 1 or 2 having
 - a means for receiving the screw-threaded engagement portion at the other end of the splines,

- a pinion at the one end of the splines, which is in the vicinity of the second housing portion and which provides the tooth arrangement, and
 - projections on a part of the periphery of the second housing portion, which engage into the pinion as a part of the rotary movement of the two housing portions relative to each other.
4. A mechanical counter according to claim 3 having
 - a pinion having four teeth, and
 - two projections on the second housing portion.
 5. A mechanical counter according to claim 3 having
 - a pinion with four teeth of which two oppositely disposed teeth are wider than the other two teeth, whereas a flank of the wider teeth bears against the lower peripheral surface of the second housing portion,
 - two projections on the edge of the second housing portion, and
 - an opening between the two projections which is larger than the width of the wider teeth of the pinion.
 6. A mechanical counter according to any one of claims 1 to 6 having
 - a transmission ratio of half a splines revolution to two actuations of the metering apparatus.
 7. A mechanical counter according to any one of claims 1 to 6 wherein
 - the pitch on the splines screw-thread is matched to the number of the metering portions and the displacement travel of the cursor.
 8. A mechanical counter according to any one of claims 1 to 7 wherein
 - the pitch on the splines screw-thread is matched to the number of the metering portions and the displacement travel of the cursor.
 9. A mechanical counter according to any one of claims 1 to 7 wherein
 - the pitch on the splines screw-thread is matched to the number of the metering portions and the displacement travel of the cursor.
 10. A mechanical counter according to claim 1 or 2 having
 - a means for receiving the screw-threaded engagement portion at the other end of the splines.

11. A mechanical counter according to any one of claims 1 to 10 having

- at least one recessing projection on the cursor.

12. A mechanical counter according to any one of claims 1 to 11 having

- a cover over the first housing portion, which cover is connected thereto rotatably in the axial direction and covers over the splines, whereas the cover is transparent in a region-wise manner or comprises transparent material.

13. A mechanical counter according to claim 12 having

- at least one enlargement covers on the inside of the cover.

14. A mechanical counter according to any one of claims 1 to 13 having

- a gear on the other end of the splines, and
- a ring gear with means for inhibiting unassisted movement, preferably with a flange, with which the gear engages, and
- which is connected coaxially rotatably relative to the first housing portion.

15. A mechanical counter according to claim 14 having

- at least one flat marking on the flange of the ring gear, which marking, after less than 360 degree rotation of the ring gear relative to the first housing portion, is disposed opposite a second marking which is in a fixed position relative to the first housing portion.

16. A mechanical counter according to claim 15 having

- a second marking on the first housing portion, or
- a window in a cover on the first housing portion.

17. A mechanical counter according to any one of claims 1 to 13 having

- a second splines with means for inhibiting unassisted movement, which is arranged in substantially parallel relationship with the first splines, and
- a cursor - which is possibly not displacement - with rotary mounting on the second splines, and
- a one-tooth transmission assembly comprising
- a projection wheel at one end of the first splines and
- a gear at the corresponding end of the second splines, into which the projection wheel at the

end of the first splines engages, and

- a scale which is disposed adjacent the cursor on the second splines.

18. A mechanical counter according to any one of claims 1 to 13 having

- a roller, on which a helical line is drawn with a revolution over the entire length of the roller and the surfaces on the two sides of the helical line are marked in different ways, preferably coloured with two colours, and
- a narrow transparent strip in the cover through which a strip on the peripheral surface of the roller is visible, and possibly a scale beside the transparent strip.

19. A mechanical counter according to any one of claims 1 to 13 having

- a second splines with means for inhibiting unassisted movement, which is arranged in substantially parallel relationship with the first splines, and
- a cursor with rotary mounting on the second splines, and
- a one-tooth transmission assembly comprising
- a tooth arrangement at the end of the second splines, which is closest to the second housing portion, and
- projections at the edge of the second housing portion, which engage into the tooth arrangement at the end of the second splines upon rotation of the housing portions relative to each other.

20. A metering apparatus having two coaxially arranged housing portions which are rotated relative to each other when the metering apparatus is operated, the metering apparatus comprising a mechanical counter according to any preceding claim.

21. A metering apparatus having two coaxially arranged housing portions which are rotated relative to each other when the metering apparatus is operated, the metering apparatus having a mechanical counter comprising a screw-threaded splines operating in bearing means on one of the housing portions in a peripheral region thereof so that it is rotated by movement of the other housing portion, and a cursor movable, by the screw-thread, relative to marker means, the arrangement being such that movement of the cursor with respect to the marker means provides a measure of the number of operations of the apparatus.

22. A metering apparatus according to Claim 21,

wherein the cursor can be temporarily released from the screw-thread for resetting.

23. A metering apparatus according to Claims 21 or 22, including means for indicating the number of times the cursor has moved through its path of travel.

24. A metering apparatus according to Claim 21, 22 or 23 wherein the splines axis is substantially parallel to the axis of rotation of the housing portions and the splines has a gear thereon which cooperates with means on said other housing portion to effect rotation of the splines.

25. A metering apparatus according to Claim 24 wherein the splines is rotated during only part of the relative rotation of the housing portions.

26. A metering apparatus according to any one of Claims 21-25, wherein the counter is as defined in any one of Claims 1-13.

27. A metering apparatus according to any one of Claims 20-25 which is a recessed case intake.

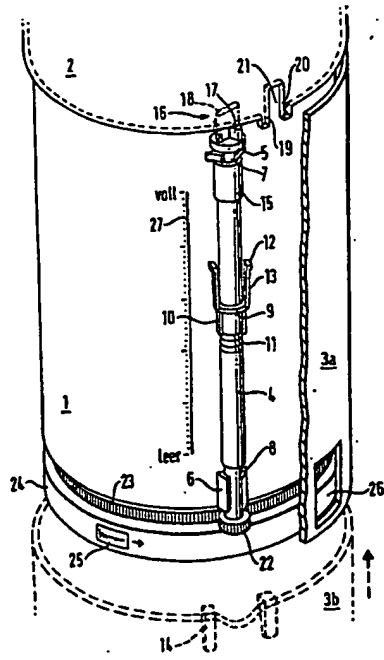


FIG. 1